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Determination of the exogeneous radiofrequency field levels and of the endogeneous energetic dose for the assessment of the bioelectromagnetic impact of ambiental and occupational exposure

- Habilitation thesis -

Simona MICLAUS

"NICOLAE BALCESCU" LAND FORCES ACADEMY, SIBIU, ROMANIA

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SUMMARY

This thesis, presented for obtaining the habilitation degree in electrical engineering, is based on all my professional and research activity done since 2003, when I have received the doctoral degree in physics, with the thesis „Interaction between high frequency electromagnetic field and complex biological structures" at the University of Bucharest.

The present habilitation thesis is structured in three parts:

1. Post-doctoral achievements in the academic, scientific and professional career
2. Scientific contributions and significant results obtained in research activity
3. Directions of the future scientific and professional development

The second part is subdiveded in two main areas, each one containing multiple sections, each section being followed by a short list of main international literature in the field and the list of own/original publications.

1. Post-doctoral achievements in the academic, scientific and professional career:

After finalising the doctoral stage and receiving the doctoral degree (in 2003), I continued the research activity mainly in the field of bioelectromagnetics and remained in the educational staff of the Land Forces Academy „Nicolae Balcescu" in Sibiu, Romania, where I continued my classes, seminaries and laboratory activties as a lecturrer professor. Later, at the same institution I earned the associate professor title (2007) and then the professor title (2015). Thrue the years since 2003 I have teached courses such as: Electrotechniques; Electromagnetism and solid state physics; Radiowaves propagation and Antennas, Nuclear physics and Dosimetry. I have also earned part-time positions as associate professor at the Technical University of Cluj Napoca - Faculty of Electronics, Teleccomunications and Information Technology (2010-present) at a master degree program where I teach the course „Bioelectromagnetic interactions and protection stantards" and at „Lucian Blaga" University of Sibiu – Faculty of Engineering (2011, 2012) where I thoght a course on „Sources of renewable energy".

In 2006 I founded the Laboratory of Radiofrequency Exposmetry and Dosimetry at the Land Forces Academy „Nicolae Balcescu" in Sibiu and started research coordination of master students in the field of high frequency bioelectromagnetics and antennas and propagation.

Thrue the years I coordinated tens of students for preparing their bachelor degree theses and their master degree theses. Some students earned special awards at national scientific competitions of students during their academic preparation.

My didactic competencies improved by experiencing teaching mobilities abroad (three times I had a teaching mobility stage at the University Nova of Lisboa in Portugal under the Erasmus program) and my educational coordonation skills were also improved during participation in educational curriculum design and in authorization documentation preparation for two new bachelor degree programs implemented in Land Forces Academy in Sibiu in the radiocommunication area (2014 and 2017).

I was a coordinator of three national research projects obtained by competition and member of the research team in other six national research projects obtained by competition. I had a grant for a research mission of one month at a bioelectromagnetics

laboratory in Trento, Italy (2005). I had two collaborations in international projects: one with France (2009-2010) and another with Greece (2013-2014).

I was a member of the management committee (or suppleant) in two European COST Actions: 1) Action BM0704 "Emerging electromagnetic field technologies and health", 2008-2012; 2) Action BM1309 - "European network for innovative uses of electromagnetic fields in biomedical applications (EMF-MED) " 2014-2018.

The activity results public dissemination conducted to:

- 55 papers published in Clarivate Analytics - ISI Thomson database quoted journals or in ISI proceedings
- 30 papers published in journals or proceedings indexed in other international databases
- 25 participations at scientific conferences abroad
- 30 participations at scientific conferences in the country
- Hirsh index = 6 (by Clarivate Analytics / ISI Thomson Reuters database)
- Citation metrics by Clarivate Analytics / ISI Thomson Reuters databas; Sum of the Times Cited = 103 (as by 21 July 2017)
- 3 books published as unique author in editions recognized at the national level, 1 book as a main author and 2 books as co-author.

I received three professional awards and six research prises at the national level.

2. Scientific contributions and significant results obtained in research activity:

My topics of interest in research since 2003 were/are:

• exposure of dielectrics (biological structures) to radiofrequency electromagnetic fields;
• propagation of radio signals in biological objects and dosimetry;
• simulations electromagnetic energy absorption in biological objects;
• study of bio-electromagnetic interactions by physical methods;
• ionospheric propagation of radio waves in the high frequency range;
• theoretical analysis of the correlation between electromagnetic and gravitational forces.

The most significant contributions presented in this thesis cover two main areas of knowledge:

- radiofrequency fields exposimetry
  and
- dosimetry (energy deposition) of radiofrequency radiation in biological objects.

One important aspect in the exposimetric topics was determining the realistic human exposure levels in the far field of radiofrequency sources and improving the accuracy of measuring quasi-stochastic signals. For this large objective, we approached and solved next issues:

A. A comparison of the theoretical estimations with experimental measurements made with a frequency selective measurement system in order to determine the electric field strength / power density levels of the mobile communication GSM900 signals arising from the sectoral antennas of the base stations.

B. Determining the electrical field strength due to wireless local area network (WLAN) router antennas emissions in the IEEE 802.11b / g communication standard, indoor.

C. Establishment of the magnitude level of environmental electromagnetic pollution arising from radiofrequency sources (80MHz-2.5GHz) in the area of urban spots, by in-situ made in two towns in the country.

D. Developing of an original method of traceability of the temporal variability of signal levels in downlink channels of GSM900 mobile telephony and of the integrated signal level over the whole downlink band - for a realistic assessment of human exposure.

E. Developing of an original method of determining the environmental field level in the coverage area of quasi-stochastic signal networks (Wi-Fi, WLAN) and highlighting the variables on which the exposure level depends.

Another interesting aspect in radiofrequency exposimetry was the investigation of the near-field zone of antennas and the impact of such exposure on biological objects situated nearby. In this regard, I contributed with results in the next directions:

F. Exposure assessements in the near field of portable transceievers monopole antennas emitting in the HF and VHF ranges (professional and public use).

G. A cause-effect analysis of exposure to the reactive / radiative near-field of a dipole antenna in the VHF range. The role of extrinsic and intrinsic variables in generating induced currents in the lower limbs of humans.

H. An alternative expo-dosimetric approach of the near-field level of mobile phones: radiated power in their proximity.

The radiofrequency dosimetry topics was focused in two directions: experimental and numerical determination of absorbed power in biological objectes impinged by radiowaves. The next directions and results were presented in the habilitaion thesis:

I. Experimental dosimetry in human head phantoms: dosimetric approach of UHF portable transceivers placed in front of the face by using electric-field immerssable probe conducted by the robot in the shielded room.

J. An original approach of the contribution of the magnetic field component to the specific absorption rate of energy deposition in the brain containing ferrimagnetic nanocrystals.

K. Characterization of electromagnetic shielding properties of some textile materials containing metallic wires, by far- and near-field measurement methods.

L. Experimental and numerical dosimetry for biological samples placed in transverese electromagnetic cell: blood, vegetal tissues, seeds.

3. Directions of the future scientific and professional development:

A number of seven future objectives were formulated in the area of widening of teaching and professional activities and competences, the most important being: a) sustaining the students and young researchers in all modalities, to improve their skills and to transform their potential in action, including attraction of master students to doctoral stage preparation; b) preparing customized course notes and application notes destined to (master, Ph.D.) students on the topics „radiowaves propagation in non-guided environments / dielectric and magnetic environments" c) indetifying and attracting romanian and foreign young researchers to contribute to restricted/narrow topics developed during research projects evolution into emerging vistas.

A number of other seven objectives are formulated in the area of future research activity, the main being oriented in the directions in which original results are expected from our team in the next years:

- implementation of a drone based system for the vertical characterization of electromagnetic pollution in urban areas;
- evaluation of realistic exposure due to the 5th generation of mobile communications devices;
- experiments on the use of antennas for body-centric wireless communication and networks;
- bio-medical applications of electromagnetic waves: direct and indirect effects of pulsed waves;
- the use of magnetic bacteria as sensors and tracers of the variability of radiofrequency magnetic field component;
- propagation of HF ionospheric waves under ner vertical skywave incidence

Short term scientific missions in several laboratories abroad, obtained through COST Actions participation, will be another target destined to human research specialization in our team.

Sibiu, 23 July 2017